Mathematical Modeling:
Maybe the Most Exciting and Challenging CCSS-M Change!

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What is Mathematical Modeling? (adapted from SBAC Claim 4 Specifications Document)

The process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decision-making. (p.72, CCSSM)

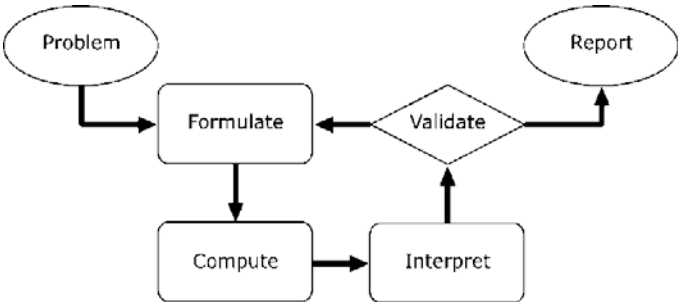
In the real world, problems do not come neatly 'packaged'. Real world problems are complex, and often contain insufficient or superfluous data. Mathematically proficient students can apply the mathematics they know to solve problems
arising in everyday life, society, and the workplace by:

- Identifying important quantities in a practical situation
- Making assumptions and approximations to simplify a complicated situation
- Mapping relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas
- Analyzing relationships mathematically to draw conclusions
- Interpreting mathematical results in the context of the situation
- Reflecting on whether the results make sense
- Possibly improving the model if it has not served its purpose. (Practice 4; CCSSM)

A well-formulated task is NOT mathematical modeling, although it may be problem solving.

Mathematical Modeling assessment tasks will involve:

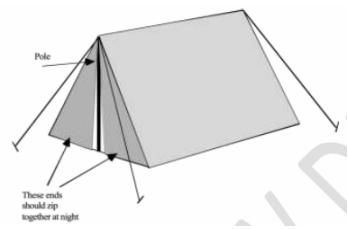
- Formulating a problem that is tractable using mathematics (DOK Level 3) - formulating a model. This will usually involve making assumptions and simplifications. Students will need to select from the data at hand, or estimate data that are missing. (Such tasks are therefore distinct from the problem solving tasks described in Claim #2, that are well formulated).
- Students will identify variables in a situation, and construct relationships between these. When students have formulated the problem, they then tackle it, often in a decontextualized form, before interpreting their results and checking them for reasonableness.
- Finally, students interpret, validate and report their solutions through the successive phases of the modeling cycle, illustrated in the following diagram from CCSSM. (DOK Level 4)



When making mathematical models, students will know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data.

The Wave -- If our entire school was sitting in the auditorium, how long would it take us to do a Wave?

Design a Tent (Grade 8)



Your task is to design a 2-person tent like the one in the picture.

Your design must satisfy these conditions:

- It must be big enough for someone to move around in while kneeling down, and big enough for all their stuff.
- The bottom of the tent will be made from a thick rectangle of plastic.
- The sloping sides and the two ends will be made from a single, large sheet of material.
- Two vertical tent poles will hold the whole tent up.

Make drawings to show how you will cut the plastic and the material.

Make sure you show the measures of all relevant lengths and angles clearly on your drawings, and explain why you have made the choices you have made.

Planning a Class Trip

You and your friends on the Class Activities Committee are charged with deciding where this year's class trip will be. You have a fixed budget for the class and you need to figure out what will be the most fun and affordable option. Your committee members have collected a bunch of brochures from various parks - e.g., Marine World, Great Adventure, and others (see inbox of materials) - which have different admissions costs and are different distances from school. You have also collected information about the costs of meals and buses. Your job is to plan and justify a trip that includes bus fare, admission and possibly rides, as well as lunch, within the fixed budget the class has.

Choosing for the Regionals

Our school has to select a girl for the long jump at the regional championship. Three girls are in contention. We have a school jump-off. Their results, in meters, are given below:

Elsa	Ilse	Olga
3.25	3.55	3.67
3.95	3.88	3.78
4.28	3.61	3.92
2.95	3.97	3.62
3.66	3.75	3.85
3.81	3.59	3.73

Hans says, "Olga has the longest average. She should go to the championship."

Do you think Hans is right? Is Olga the best choice? Explain your reasoning.

Young children can engage in complex mathematical and scientific investigations, given appropriate teacher support (http://eprints.qut.edu.au/1640/1/Englishchapter.pdf)

The Snack Chip Consumer Guide Problem (English, 2002a)
Students are presented with an introductory article on consumer guides, with questions to answer about the article. They are then given the following problem, with various packets of snack chips provided for them.

In this investigation, you will be developing a consumer guide to help people determine which type of snack chip is the best to buy. It is your decision what to focus on in your consumer guide. Your consumer guide must help people in choosing any snack chip, not just the ones you use in this activity.

As a whole class, brainstorm some factors or criteria that you might consider when you are trying to work out which chip is the best to buy. Think about what we could mean by *best*. Next, in your groups, discuss the following.

1. Describe the nature or type of factors that the whole class brainstormed. What type of information does each factor give you?
2. How might you categorize the factors?
3. How might you rate the factors to help the consumer determine which packet of snack chips they should buy?

Clean-Up! (http://commoncore.lacoe.edu/resources/training_120911/3_modeling_20111209.ppt)

Your neighborhood wants to host a yard clean-up on a Saturday next month. They have asked your class to help plan this event. They want you to determine how much this will cost for supplies. They will clean yards, alleys, driveways and streets. All decisions about how to do this are yours.

PISA Rubric on Modeling

(from http://myboe.org/cognoti/content/file/resources/documents/1c/1c849db4/1c849db47068c6cf0c42c4b086f0c5f56b7f496a/pisaRubric.pdf)

Level 0: Situation is purely mathematical or context is unnecessary for solving the problem

Level 1: Interpret and transfer directly from a given model. Translate directly from a situation into mathematics.

Level 2: Modify or use a given model to satisfy changed conditions or interpret inferred relationships.

Level 3: Create a model where the assumptions, variables, relationships, and constraints are to be identified and defined.

Smarter Balanced Assessment Consortium

Robot Maker—Task 1

You work for a company that makes robots. Your boss has asked you to design a new robot. The robot will contain a head, a body, 2 arms, and 2 legs.

The first step is to draw what the front of your robot will look like. Use the practice grid paper provided to draw the front of your robot. Make sure to follow **all** of the guidelines below.

Guidelines:

1. The front of the body must be a rectangle with an area that is greater than 64 square centimeters but less than 140 square centimeters.
2. The front of the head must be a rectangle with a perimeter of 18 centimeters.
3. The front of each leg must be a quadrilateral that is **not** a rectangle.
4. The front of each arm must be a rectangle divided into equal parts with $\frac{3}{4}$ of the parts shaded.
5. Each eye must be shaped like a hexagon divided into equal parts with $\frac{1}{3}$ of the parts shaded.

The drawing must contain labels with any numbers and words that help your boss understand how you met each of the five guidelines.